



STOCK ASSESSMENT OF NAFO SUBDIVISION 3PS THORNY SKATE

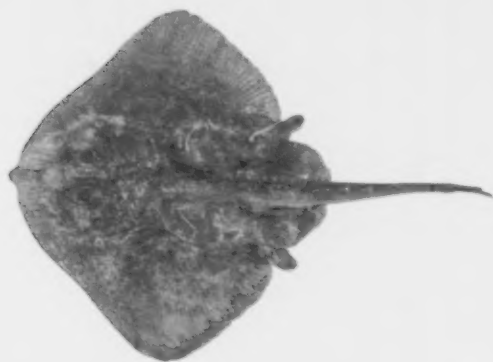


Photo: Carolyn Miri, DFO-NL Region

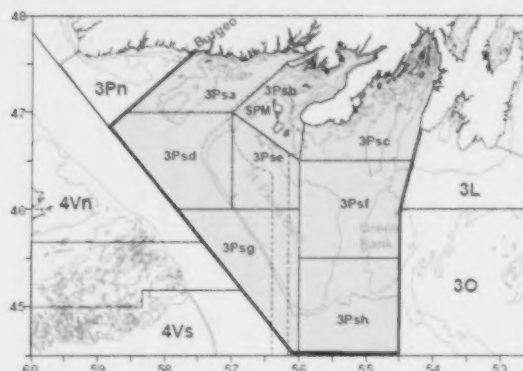


Figure 1. Subdivision 3Ps Management area (shaded), unit areas (solid lines) and economic zone around the French Islands of St. Pierre and Miquelon (SP&M-dashed line).

Context:

Thorny Skate (*Amblyraja radiata*) are widely distributed in depths ranging from 18 m to over 1500 m, in temperatures from -1.4° to about 6°C , and on both hard and soft bottoms. Previous studies indicated that Thorny Skate undergo seasonal movements toward the shelf edge in the winter/spring, returning onto the bank in midsummer and fall; probably to spawn. Thorny Skate in NAFO Subdivision 3Ps (Fig. 1) and adjacent Divisions 3LNO are considered to constitute a single stock.

Life span of Thorny Skate in waters around the Island of Newfoundland is unknown. The time between tagging and recapture of some individuals suggests that they can live at least twenty years. They deposit 6-40 egg cases per year; each of which contain a single embryo. Males mature at smaller sizes than females, and size at maturity increases from northern to southern latitudes. Limited data suggest that reproduction occurs during the summer/fall period. Thorny Skate feed on a wide variety of prey, including invertebrates and fish.

Until the mid-1990s, there was limited interest by the Canadian fleet to fish for skate in waters around the Island of Newfoundland. Previously, skate was usually discarded; even though it constituted the most common non-commercial bycatch in offshore trawler catches. This bycatch was not reported in Canadian landings statistics. Most of the reported landings before 1994 were attributable to non-Canadian fleets. With the decline of other groundfish resources, Canadian interest in skate increased and a TAC of 1,000 t was introduced in 1995 for NAFO Subdivision 3Ps (inside Canada's 200-mile limit), raised to 2,000 t for 1996; then lowered and maintained by Canada at 1,050 t as of 1997. Outside Canada's EEZ, skate catch was regulated by the Northwest Atlantic Fisheries Organization (NAFO) in September 2004 with an annual TAC of 13,500 t for 2005-2009 in NAFO Divisions 3LNO. This TAC was reduced to 12,000 t for 2010-2011, and 8,500 t for 2012.

The present assessment is the result of a request for science advice from the Fisheries Management (FM) Branch (NL Region). The main objective was to evaluate the status of the stock and to provide scientific advice relevant to the determination of a TAC in Subdivision 3Ps.

SUMMARY

- Thorny Skate in NAFO Subdivision 3Ps and adjacent Divisions 3LNO are considered to constitute a single stock.
- Life history characteristics of Thorny Skate result in low intrinsic rates of population growth; thereby leading to low resilience to fishing mortality.
- In Subdivision 3Ps, total reported landings averaged 1,308 t from 1994-2009. Landings during 2010 and 2011 averaged 808 t.
- The Canadian research survey abundance index for Subdivision 3Ps was relatively stable from 1993-2012, while the survey biomass index indicated a gradually increasing trend.
- In adjacent NAFO Divisions 3LNO, Canadian research survey indices declined rapidly until the early 1990s. Similar to Subdivision 3Ps, the Canadian Divisions 3LNO survey abundance indices were relatively stable in 1993-2012, while the survey biomass indices have generally been increasing.
- The pre-recruitment index has been above average (1996-2011) for the past three years. However, it is unclear how the pre-recruitment index relates to spawning stock recruitment.
- The exploitation rate for Thorny Skate in Subdivision 3Ps is unknown; therefore, there is no scientific basis with which to recommend a particular TAC.

INTRODUCTION

Thorny Skate (*Amblyraja radiata* Donovan, 1808) is widely distributed in temperate and Arctic waters of the North Atlantic. In the western Atlantic, Thorny Skates are distributed from Greenland to South Carolina, with the center of distribution on the Grand Banks (NAFO Divisions 3LNO). Commercial skate catches consist of several skate species; however, Thorny Skate dominates the catch composition. In Canadian commercial catches, about 95% of the Skate catch are Thorny Skates (Kulka and Mowbray 1999; Kulka and Miri 2007); similar to the proportion of Thorny Skate in EU-Spain research survey catches in NAFO Div. 3NO (González-Costas et al. 2012). Thus, the skate fishery on the Grand Banks can be considered a directed fishery for Thorny Skate.

Species Biology

Stock structure: Based on a continuous distribution and lack of physical barriers between the south coast of the Island of Newfoundland (NAFO Subdiv. 3Ps) and the Grand Banks (NAFO Div. 3LNO), Thorny Skate in NAFO Subdiv. 3Ps and adjacent Div. 3LNO are considered to constitute a single stock.

Spawning: Life history characteristics of Thorny Skate result in low inherent rates of population growth, thereby leading to low resilience to fishing mortality. The life span of Thorny Skate in Newfoundland and Labrador waters is unknown. The time between tagging and recapture of some individuals suggests that they can live at least twenty years. They deposit 6-40 egg cases per year, each of which contain a single embryo. Limited data suggest that reproduction occurs during the summer/fall period.

Maturation: Males mature at smaller sizes than females, and size at maturity increases from northern to southern latitudes.

Distribution: Thorny Skate is widely distributed in depths ranging from 18 m to over 1500 m, in temperatures from -1.4°C to about 6°C, and on both hard and soft bottoms (Fig. 2). Previous studies indicated that Thorny Skate undergo seasonal movements toward the shelf edge in the winter/spring, returning onto the Bank in midsummer and fall, probably to spawn. In NAFO Subdiv. 3Ps, Thorny Skate are distributed on Burgeo, St. Pierre, and Green Banks, and also in the deeper waters of the Laurentian, Hermitage, and Halibut Channels. Prior to the stock decline and period of spatial contraction, Thorny Skates were distributed throughout NAFO Div. 3LNO and Subdiv. 3Ps; including the shallower areas of the Grand Banks.

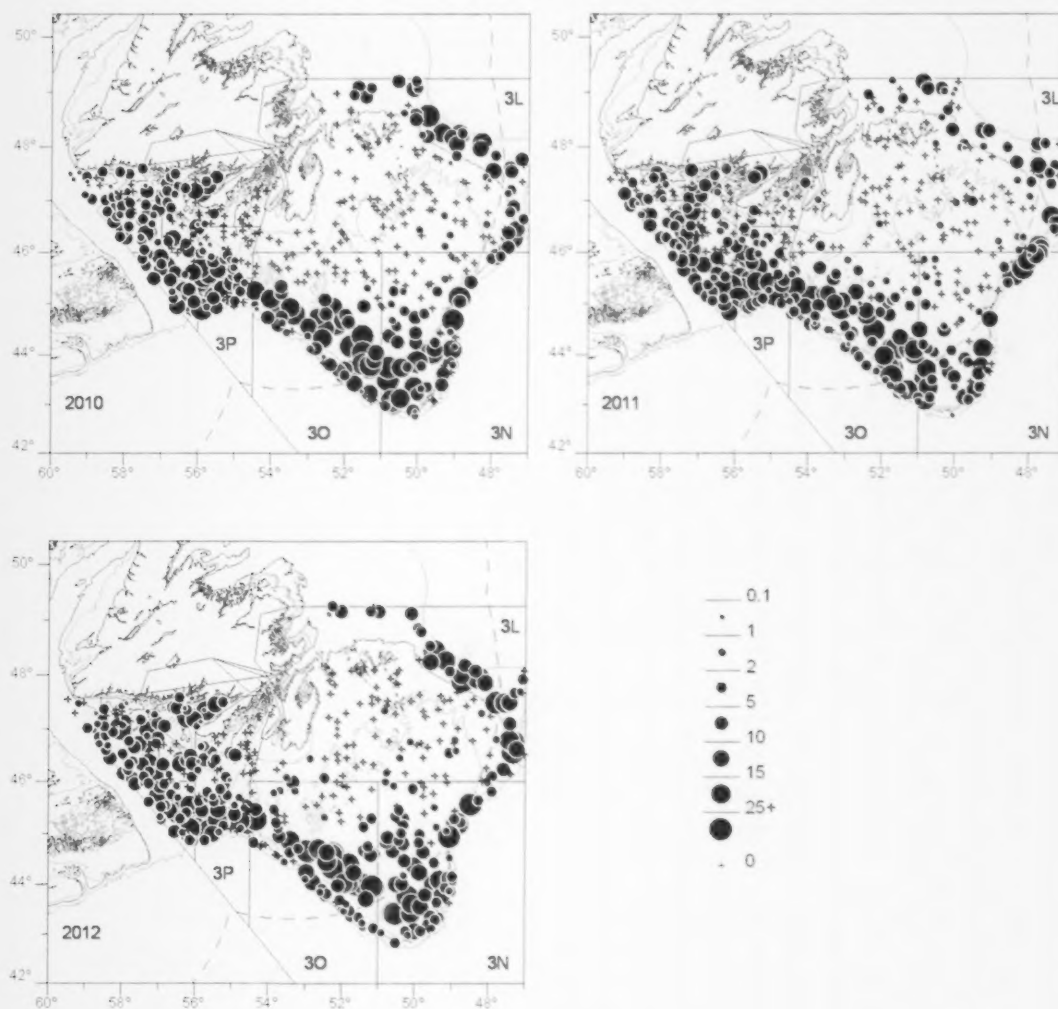


Figure 2. Distribution of Thorny Skate on the Grand Banks (NAFO Subdiv. 3Ps), based on Canadian spring research surveys in 2010 (Upper Left), 2011 (Upper Right), and 2012 (Lower Left).

The Fishery

TAC Regulation

Thorny Skate came under quota regulation in 1995, after a directed skate fishery was established in 1994 by Canada in its Exclusive Economic Zone (EEZ). A Total Allowable Catch (TAC) of 1,000 t for NAFO Subdiv. 3Ps was adopted by Canada in 1995, along with gear and bycatch policies. In 1996, the TAC was raised to 2,000 t for Subdiv. 3Ps; then reduced and maintained by Canada at 1,050 t as of 1997.

Outside Canada's 200-mile limit, catch was unregulated until September 2004, when the Northwest Atlantic Fisheries Organization (NAFO) set a TAC of 13,500 t for 2005-2009 in Div. 3LNO. This TAC was lowered to 12,000 t for 2010-2011, and to 8,500 t for 2012.

Catch Trends

In NAFO Subdiv. 3Ps, NAFO-reported landings (STATLANT-21A) for all countries combined averaged 505 t during 1970-1979, and increased to 975 t in 1980-1989 (Fig. 3). During the early 1990s, reported landings of skates in Subdiv. 3Ps declined to 33 t by 1993. In Subdiv. 3Ps, total reported landings averaged 1,308 t from 1994-2009. Landings during 2010 and 2011 averaged 808 t. It should be noted that the TAC was often exceeded during the past decade (Table 1).

Table 1. Reported skate landings from NAFO Subdiv. 3Ps (in tons). Note that "Other" landings in 2009-2011 represent data from St. Pierre and Miquelon (EU-France; pers. comm. Joel Vigneau-IFREMER).

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
TAC	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050
Canada	1,769	1,413	1,705	1,190	967	910	1,347	763	645	342	517
Other	39	238	82	87	15	78	491	633	354	529	228
Total	1,808	1,651	1,787	1,277	982	988	1,838	1,396	999	871	745

NAFO data also indicated that, from 1994-2008, Canadian fleets reported the majority of Thorny Skate landings in Subdiv. 3Ps, while St. Pierre and Miquelon (EU-France) reported small annual skate landings (Table 1, Fig. 3). Prior to commencement of a new Canadian skate-directed fishery in 1994, reported Canadian landings of Thorny Skate in Subdiv. 3Ps rarely exceeded a hundred tons, with the exception of 1977-1981 when Canadian landings averaged 526 t. Reported Canadian landings averaged 1,247 t in 1994-2007, and 567 t in 2008-2011.

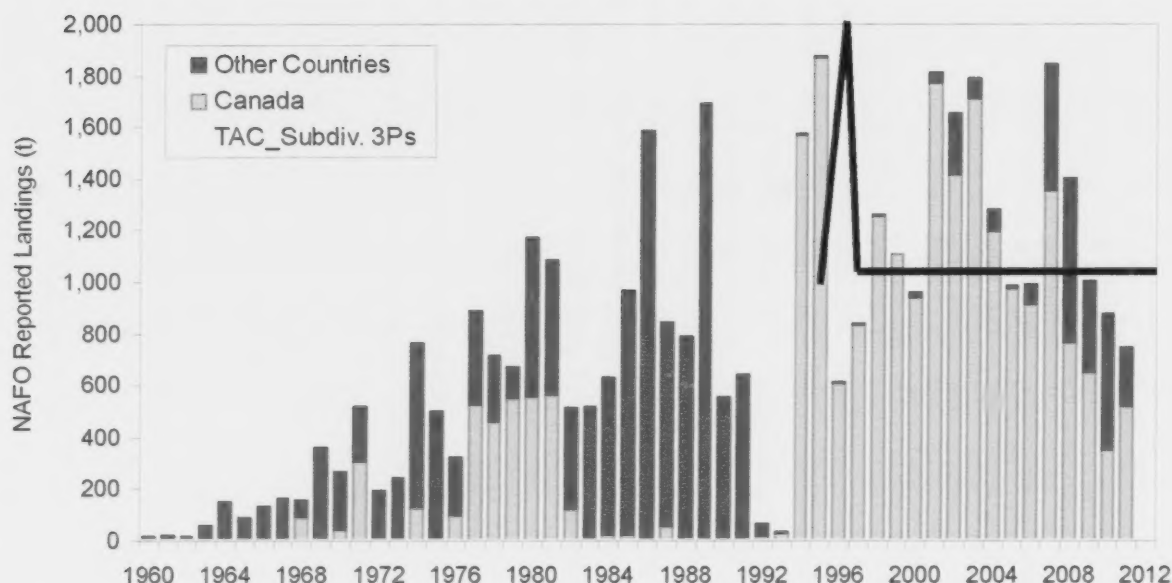


Figure 3. NAFO-reported landings (tons) of Thorny Skate by Canada and other countries in NAFO Subdiv. 3Ps in 1960-2011 (STATLANT-21A). Data do not include discards at sea. TAC in Subdiv. 3Ps is set by Canada's Department of Fisheries and Oceans (DFO).

In other portions of the stock area (NAFO Div. 3LNO), significant bycatches of skates have been taken since commencement of offshore fishing in the late 1940s; initially by non-Canadian fleets and later by Canadian vessels. Prior to the mid-1980s, non-Canadian fleets comprised the largest component of offshore fisheries on the Grand Banks, and took several thousand tons of skate as bycatch each year (Fig. 4). The bycatch occurred primarily as a consequence of the Greenland Halibut fishery (*Reinhardtius hippoglossoides*) and from the Canadian mixed fishery for Thorny Skate, White Hake (*Urophycis tenuis*), and Monkfish (*Lophius americanus*). From 1985-1991, reported skate landings averaged 17,000 t, and peaked at approximately 28,400 t in 1991. This fishery was prosecuted mainly by Spain, Portugal, and the USSR (Junquera and Paz 1998; del Río and Junquera 2001). Non-Canadian landings declined significantly to 5,059 t in 1992. After a peak of 18,277 t in 2000, total reported landings of skate, as reported by all countries in NAFO Div. 3LNO declined. Preliminary NAFO estimates suggested that 5,389 t of Skate were landed from Div. 3LNO in 2011.

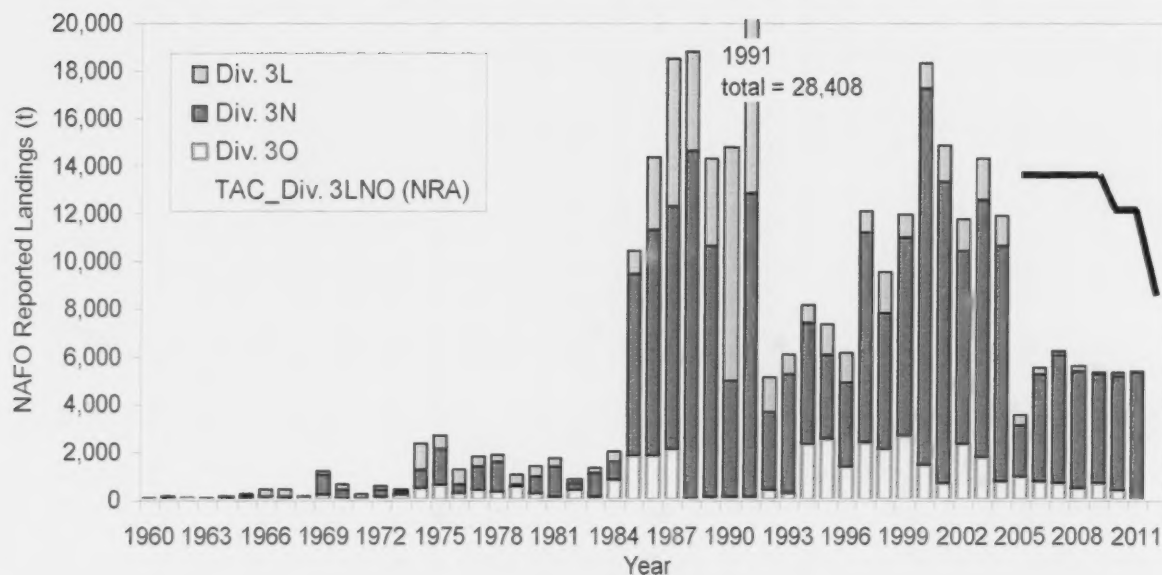


Figure 4. NAFO-reported landings (tons) of Thorny Skate by Canada and other countries in NAFO Div. 3LNO in 1960-2011 (STATLANT-21A). Data do not include discards at sea. TAC in the NAFO Regulatory Area (NRA) of Div. 3LNO is set by the Northwest Atlantic Fisheries Organization (NAFO).

The level of total commercial removals of Thorny Skate is uncertain. It is highly probable that historical landings records have been biased both upwards (e.g., due to misreporting of landings by location and/or species) and downwards (e.g., due to unreported discards at sea). In assessing stock status, it is crucial that commercial skate landings data be reported by species, and that commercial discards of Thorny Skate at sea be reported; in order to reliably estimate total commercial removals from the population.

ASSESSMENT

Resource Status

Sources of information

Stock status was updated using commercial landings reported by Canadian fishers operating in Canada's EEZ (1985-2011), commercial landings reported by NAFO-member countries in the NAFO Regulatory Area (NRA) of Div. 3LNO (1960-2011), length distributions of commercial catches sampled at sea by Canadian Fisheries Observers, and relative biomass and abundance indices from Canadian research trawl surveys conducted in spring (Div. 3LNOPs in 1972-2012, with the exception of 2006) and fall (Div. 3L in 1981-2011; Div. 3NO in 1990-2011).

Research vessel surveys

Canadian stratified-random bottom trawl surveys have been conducted by DFO in NAFO Subdiv. 3Ps since 1972. Surveys from 1972-1982 entailed relatively low coverage; with fewer sets per year on average. In addition, the DFO spring survey in 2006 was not completed; due to unforeseen mechanical difficulties aboard research vessels. Canadian spring research surveys are considered to reflect trends in the Thorny Skate population, however, there have been changes in the timing and spatial coverage of the survey over the time series.

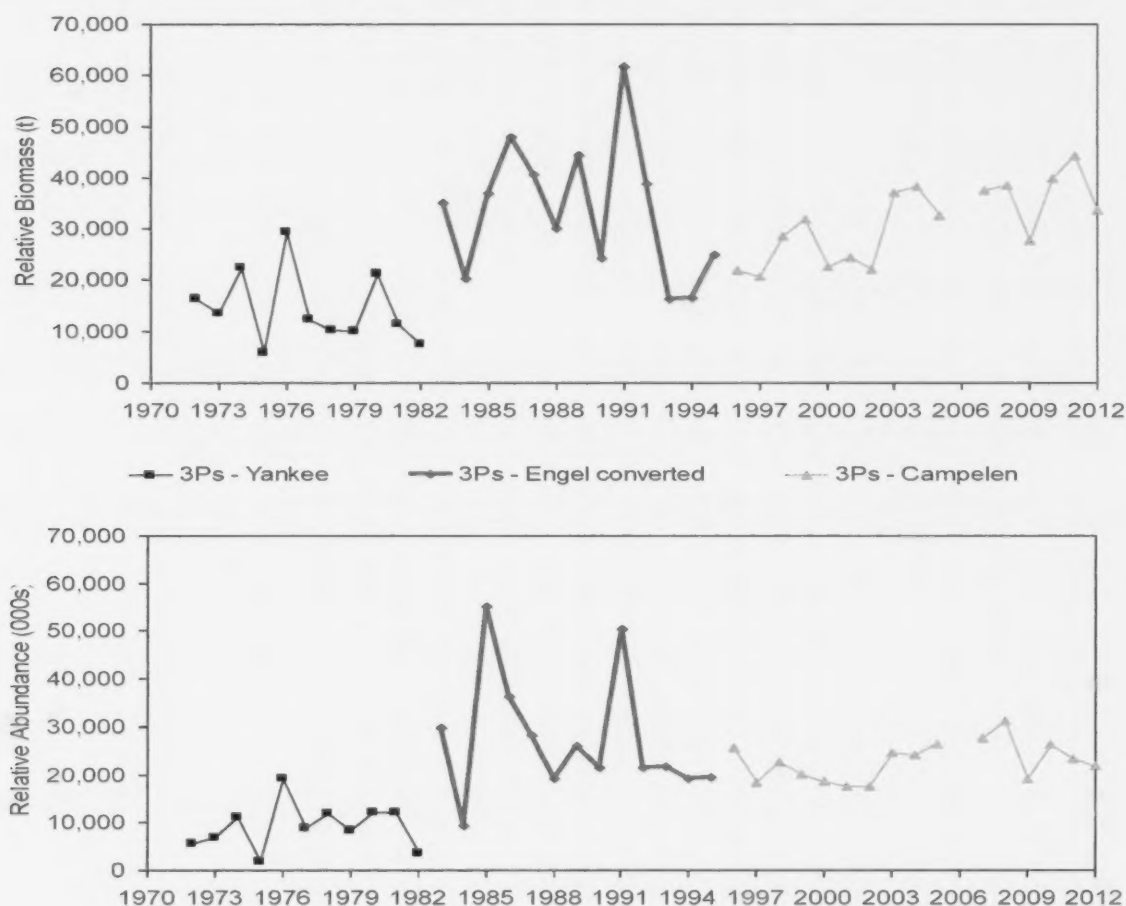


Figure 5. Canadian spring research survey biomass and abundance indices for Thorny Skate in NAFO Subdiv. 3Ps in 1972-2012. Note that Subdiv. 3Ps was not surveyed in 2006, due to mechanical difficulties on Canadian research vessels.

In Subdiv. 3Ps, spring biomass indices from Campelen surveys suggest a gradually increasing trend over 1993-2012; averaging 31,400 t with a peak at 44,310 t in 2011 (Fig. 5). Previously, the spring biomass index averaged 33,500 t during Engel survey years (using Campelen-equivalents); with peaks of 47,728 t in 1986 and 61,534 t in 1991. The Subdiv. 3Ps spring abundance index fluctuated around 23 million Skates in 1996-2012 with a peak of 31 million fish in 2008, and averaged 29 million fish in the Engel years; except for peaks of 55 million fish in 1985 and 50 million fish in 1991 (Campelen-equivalents; Fig. 5). Overall, the Canadian research survey

abundance index for Subdiv. 3Ps was relatively stable from 1993-2012, while the survey biomass index indicated a gradually increasing trend.

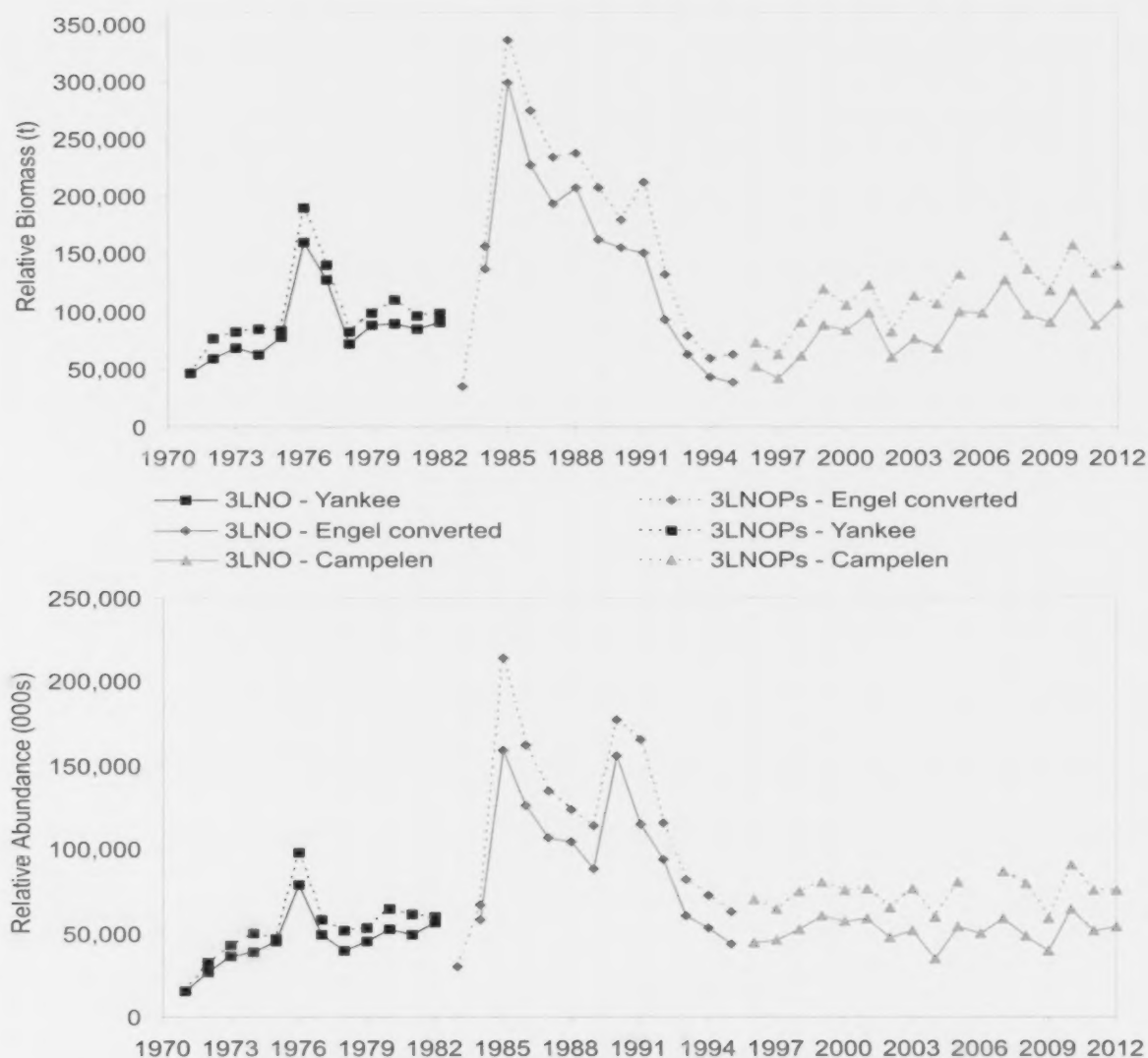


Figure 6. Canadian spring research survey biomass and abundance indices for Thorny Skate in NAFO Subdiv. 3Ps and Div. 3LNO, 1971-2012. Note that Div. 3LNO were not surveyed in 1983; Subdiv. 3Ps was not surveyed in 2006; nor was the deeper portion (>103 m) of Div. 3LNO in that year, due to mechanical difficulties on Canadian research vessels.

Considering the other three Divisions combined (Div. 3LNO), Canadian spring surveys showed that the biomass index averaged 147,200 t during Engel survey years (1984-1995; using Campelen-equivalents); with peaks of 299,112 t in 1985, 226,823 t in 1986, and 207,204 t in 1988, and a rapidly declining trend to 38,000 t in 1995 (Fig. 6). In Campelen survey years (1996-2012), relative biomass followed a gradually increasing trend, with an 85,500-ton average annually. The Div. 3LNO spring abundance index fluctuated around 51 million Skates in 1996-2012, and averaged 97 million fish in the Engel years; except for peaks of 158 million fish in

1985 and 156 million fish in 1990 (Campelen-equivalents; Fig. 6). Overall, in adjacent NAFO Div. 3LNO, Canadian research survey indices declined rapidly until the early 1990s. Similar to Subdiv. 3Ps, the Canadian Div. 3LNO survey abundance indices were relatively stable in 1993-2012, while the survey biomass indices have generally been increasing.

A relationship between mature female abundance and Thorny Skate young-of-the-year (YOY; 5-20 cm TL) from Canadian spring surveys of Div. 3LNOPs in 1985-95 (Engel trawl) and 1996-2011 (Campelen trawl) is illustrated in Figure 7. This pre-recruitment index followed an increasing trend in the Engel years; averaging 1.6 (peak of 4.2 in 1995). However, in the Campelen years, this index declined from 1.9 and 2.4 in 1996 and 1997 (respectively) to an average of 0.9 since 1998, with the lowest value of 0.45 occurring in 2003, and a recent peak of 1.6 in 2009. The latest index (2011) was 1.3. The pre-recruitment index has been above average (1996-2011) for the past three years. However, it is unclear how the pre-recruitment index relates to spawning stock recruitment.

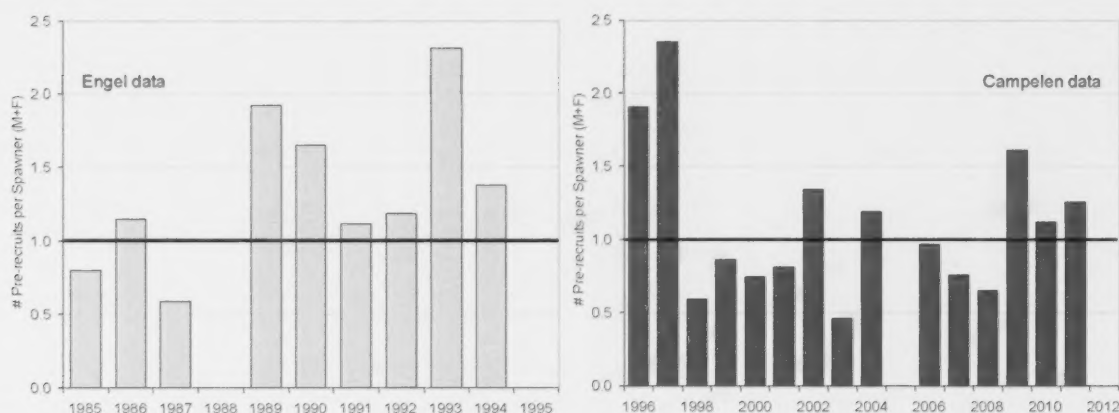


Figure 7. Pre-recruits per spawner expressed as number of male and female pre-recruits (in year $[y]$ produced per adult female in year $[y-1]$) from Canadian Campelen spring surveys in NAFO Div. 3LNO and Subdiv. 3Ps, 1985-95 (Engel; left panel) and 1996-2011 (Campelen; right panel). Note that Subdiv. 3Ps was not surveyed in 2006, and one-year-old skates in 2006 were caught only from the shallow (<104 m) portion of Div. 3NO due to incomplete survey coverage for that year. Panels are not comparable due to different gear types.

Sources of Uncertainty

The assessment of the status of Thorny Skate is limited by a paucity of information on the life history of this species, and uncertainties regarding its commercial catch history. Information on growth rates, age of maturity, and details of the age structure of the Div. 3LNO and Subdiv. 3Ps population are lacking. Thus, it is not possible to undertake age-based analyses, or estimate its spawning stock biomass with any certainty. This lack of data is accentuated in the development of stock-recruit relationships, and modeling of Thorny Skate stock dynamics.

Lack of speciated commercial skate landings, misreporting of fishing locations and/or species caught, and unreported discards at sea, place substantial restrictions on the evaluation of fishing mortality of Thorny Skates, as does the reliance on a single annual Canadian research survey in Subdiv. 3Ps.

Since the 1980s, Thorny Skate has undergone substantial changes in its distribution. This species has become increasingly aggregated in Subdiv. 3Ps, and on the southern part of the Grand Banks.

The result is a decreasing area of occupancy, and increasing catch rates in commercial fisheries occurring in those areas where skates are aggregated. Despite a number of years of reduced commercial landings, there was no recovery of Thorny Skate in the Div. 3LNOPs stock area, although abundance appeared stable in the Subdiv. 3Ps portion of the stock area.

ADDITIONAL STAKEHOLDER PERSPECTIVES

The skate fishery in the Subdiv. 3Ps portion of the 3LNOPs skate stock remains stable; however, declines have been observed by harvesters in areas which had been previously fished on a consistent basis. In the offshore, increases have been observed in both skate abundance and body size in deeper waters. Due to many challenges facing the NL groundfish industry, it is anticipated that the skate quota will remain untaken over the next few years.

CONCLUSIONS AND ADVICE

Reported commercial landings of Thorny Skate in Subdiv. 3Ps have declined in recent years.

Discarding of skate bycatch at sea remains unreported by Canadian and other fishers, resulting in higher removals from the Thorny Skate stock than available fisheries statistics indicate.

Commercial skate landings remain unspeciated when reported by Canadian and other fishers. Reporting of skate landings by species should be made mandatory for commercial fishers operating in Canada's EEZ. In addition, annual Observer coverage should be increased for fisheries with significant skate bycatch to provide data to improve estimates of fishing mortality.

Distribution and abundance of Thorny Skate in Subdiv. 3Ps have been stable over the near-term; whereas biomass is gradually increasing.

Biomass and abundance indices for the entire Div. 3LNO and Subdiv. 3Ps Thorny Skate stock area remain at relatively low levels.

The exploitation rate for Thorny Skate in Subdivision 3Ps is unknown; therefore, there is no scientific basis with which to recommend a particular TAC.

SOURCES OF INFORMATION

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, Regional Advisory Meeting held on Oct. 9, 2012 regarding the stock assessment of Subdiv. 3Ps Thorny Skate. Additional publications from this process will be posted as they become available on the DFO Science Advisory Secretariat website at <http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm>.

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